ABSTRACT

The aim of this work was to investigate the effect of additives, such as the type of dedusting emulsion and the dispersion of nanoparticles of metal oxides, in a binder mixture based on a phenol-formaldehyde resin, on the properties of the products of rock mineral wool.

In the first part of doctoral dissertation I focused on the investigation of the type of dedusting emulsions used in the binder. I was studying the possibility of replacing the existing dedusting emulsion based on mineral oil with emulsion based on renewable, natural vegetable oil with the addition of different types of emulsifiers or dedusting emulsion based on siloxane oil. I confirmed the hypothesis that the replacement of mineral oil with vegetable oil is possible for the preparation of emulsions, in case when we use an anionic emulsifier, preferably a salt of lignosulfonate. It is also possible to replace the mineral oil with a siloxane type of dedusting agent, only the stability of the binder mixture is slightly lower than that of the dedusting emulsion based on mineral oil. Before the tests in production, the laboratory investigations had to confirm the further approved usage of material. Therefore I tested the time stability of binder mixtures containing various dedusting emulsions. In the next step, I studied the properties of the sandbars made of suitable sand and binder mixtures which contained stable or potentially stable dedusting agents. I also investigated the impact of the added dedusting agent to environmental emissions and confirmed that added dedusting emulsion in the binder affected well the amount of emitted total organic carbon and other undesirable compounds, particularly formaldehyde.

In the second part of the doctoral dissertation I focused on the preparation of stable dispersions of nanoparticles of metal oxides as well as on the preparation of stable mixtures of binders that contained nanoparticles, which I later tested in the production. I found out that the metal particles, which were not in the range of nano dimensions (MgO), were not suitable for further testing. The nanoparticles of SiO_2 and TiO_2 minerals were confirmed as suitable and a mixture of thereof as well. I found out that the mechanical properties of the products (facade boards) made with 35% less binder and with the addition of nanoparticles were comparable to the properties of the products that were made with a standard binder mixture of standard quantity and without nanoparticles. The mechanical properties of the facade panels` were improved even after nine or twelve months of testing. Technology of adding nanoparticles into the binder mixture was successfully tested on several types of products as well as on independent equipment in a different location. A smaller amount of binder used in insulation products made of mineral wool has consequently a large positive environmental impact because emissions into the environment are lower. By using specific additives in the binder mixture or simply by optimizing the composition of the existing binder mixtures makes the door open to further research and improvements in the composition of the binder mixtures for the manufacture of mineral wool products.